Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers

Date: December 2009

Ontario Ministry of the Environment

Support for this guidance provided by

- Lake Erie Source Protection Region (LESPR)
- Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)
- Conservation Ontario

INTRODUCTION

The *Clean Water Act, 2006* sets the legal framework that ensures communities are able to protect their municipal drinking water supplies by developing collaborative, locally driven, science-based protection plans. Communities will identify potential risks to local drinking water sources and take action to reduce or eliminate these risks. Regulation 287/07 and technical rules (updated November 2009) govern the content of the assessment report. The regulation includes a list of prescribed activities that must be considered when identifying and categorizing activities that pose a risk to drinking water. The technical rules include Tables of Drinking Water Threats that set out the circumstances under which the activities in the regulation pose a significant, moderate, or low drinking water threat. Included in these tables are threats that require consideration of the percent managed lands and livestock density within vulnerable areas. The technical rules include a requirement for maps of percent managed land and livestock density to support the analysis of these circumstances. This is explained in more detail below.

In determining the percentage of *managed land,s* source protection committees must determine the areas where there may be application of agricultural source material (ASM), commercial fertilizer, or non-agricultural source material (NASM). These areas are expressed as percentages of the total area being evaluated. In determining the livestock density in an area, expressed in terms of nutrient units/acre (NU/Acre), committees have to determine nutrient units (NU) generated as a percentage of the total agricultural managed lands in the area.

The combination of the percentage of managed land and the livestock density of an area is then used as a surrogate for representing the quantity of nutrients present as a result of nutrient generation, storage, and land application within an area. This surrogate is then used to determine the potential impact of a single property on water quality.

This methodology has been developed by the Grand River Conservation Authority (GRCA) in the Lake Erie Source Protection Region (LESPR) with the support from MOE, Conservation Ontario and OMAFRA, to map the *percentage of managed lands* and calculate *livestock density* areas for use in determining the "quantity" of land applied nutrients in an area.

This technical bulletin describes a tested, consistent methodology that can be applied by any Source Protection Committee (SPC) in the province, to evaluate the circumstances in which land application of Agricultural Source Material (ASM), Non-agricultural Source Material (NASM), and Commercial Fertilizers could be considered as chemical threats in their source protection area. The approach outlined uses the combination of managed land intensity and livestock density (expressed in terms of NU/acre) to arrive at a surrogate measure of the extent of use of these chemical threats of nitrogen and phosphorus in an area of interest.

The working group also reviewed and set directions on how nutrients can be considered when determining the applicable chemical threat circumstances related to the use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. Note that pathogen threats associated with these same activities are identified and categorized using a separate, independent approach.

Although the proposed methodology is intended to assist all SPC's in calculating the percentage of managed lands and livestock densities required for the development of the Assessment Reports, the Source Protection Programs Branch of Ministry of the Environment recognizes that a SPC may choose to apply an alternative method that may be more appropriate for the local conditions or data availability for its area. The SPC should document any method used to undertake the task.

1. MANAGED LAND AND AGRICULTURAL MANAGED LAND

1.1 Background

Managed land is land to which nutrients (ASM, fertilizer, NASM) are applied. It includes, but is not limited to, cropland, fallow land, improved pasture, golf courses, sports fields, and lawns.

Managed lands can be broken into 2 subsets: agricultural managed land and non-agricultural managed land. *Agricultural managed land* includes areas of cropland, fallow, and improved pasture that may receive nutrients. *Non-agricultural managed lands* includes golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer).

The November 2009 technical rules include the development of a map that shows:

16 (9) One or more maps of the percentage of managed lands within,

(a) a significant groundwater recharge area;

(b) a highly vulnerable aquifer;

(c) each of the following areas within a vulnerable area:

(i) *WHPA-A.*

(ii) *WHPA-B.*

(iii) *WHPA-C.*

(iv) *WHPA-C1, if any.*

(v) *WHPA-D.*

(vi) *WHPA-E.*

(vii) *IPZ-1.*

(viii) *IPZ-2.*

(ix) *IPZ-3, if any.*

If two or more areas in an area referred to in clause (a) to (c) have different vulnerability scores, the percentage of managed land may be determined for each of those areas. Mapping the percentage of managed lands is not required for any area in an area mentioned in clause (a) to (c) where the vulnerability scores for that area are less than those necessary for the following activities to be considered a significant, moderate or low drinking water threat in the Table of Drinking Water Threats: the application of agricultural source material to land,

the application of non-agricultural source material to land and the application of commercial fertilizer to land. Each map prepared in accordance with this subrule shall be labelled the "managed land map".

(10) One or more maps of livestock density for each area referred to in subrule (9). Livestock density shall be determined by dividing the NUs generated in each area by the number of acres of agricultural managed land in that area where agricultural source material is applied. If two or more areas in an area referred to in subrule (9) (a) to (c) have different vulnerability scores, the livestock density may be determined for each of those areas. Mapping livestock density is not required for any area in an area mentioned in clause (9) (a) to (c) where the vulnerability scores for that area are less than those necessary for the following activities to be considered a significant, moderate or low drinking water threat in the Table of Drinking Water Threats: the application of agricultural source material to land, the application of non-agricultural source material to land and the application of commercial fertilizer to land. Each map prepared in accordance with this subrule shall be labelled the "livestock density map".

Both *managed lands* and *agricultural managed lands* are to be identified within each of the vulnerable areas where the vulnerability score for that area is high enough for activities to be considered a significant, moderate or low drinking water or for subsets of these vulnerable areas. Based on the tables, any area with a score of 6 or higher for groundwater or 4.4 or higher for surface water (including IPZs and WHPA E) can have threats identified. The percentage of managed lands and livestock density are only required for these areas as it is only in these areas where the vulnerability is high enough for a threat to be present.

For example, the *managed land* percentage must be identified within HVAs. This can be done by determining the percentage over the combined HVA area, or within several HVAs combined, or for individual HVA polygons. . Also, the subset of a WHPA-D considered in order to identify the managed lands can be either the sum of all parts of the WHPA D scoring 6, or each individual WHPA-D subset scoring 6, depending on the amount and sizes of WHPA-D subsets that score 6. Professional judgment should be applied for this decision.

The percentage of managed land area within a vulnerable area or subset of the vulnerable area should be the sum of agricultural managed land and non-agricultural managed land, divided by the total land area within the vulnerable area (or subset of the area) multiplied by 100.

Where only a portion of a *managed land* parcel falls within a vulnerable area, only the portion of the parcel within the vulnerable area should be factored into the calculations for the total *managed land* in the vulnerable area.

1.2 Considerations for Percentage of Managed Lands Calculation

(a) Delineating Areas of Agricultural Managed Lands

Agricultural managed land includes farmed areas (cropland, fallow land and improved pasture). Methods to delineate these areas may vary for each SPA and may include GIS, photo interpretation work, field inspection where the vulnerable area to be inspected is small, or a combination of these methods.

In cases where there are both the time and resources available, or where uncertainty is high as a result of discrepancies in the data collected, a roadside survey/field checking is recommended as confirmation/support of the air photo interpretation or GIS to reduce the uncertainty and make adjustments on the identification of agricultural managed lands. Also, the air-photo interpretation would be best undertaken by an individual with knowledge of general agricultural systems, and it is recommended someone with similar background and skills undertake the roadside survey as confirmation/support of the air photo interpretation, since the data collected during the field checking would also be used to confirm the estimates of the livestock density in the area.

(b) Delineating Areas of Non-Agricultural Managed Lands

Areas of non-agricultural managed lands are grassed areas that may receive commercial fertilizers such as residential lawns, sports fields and golf courses.

Golf Courses

Methods to determine golf course area vary with local availability of data and may include direct measurement using air photo interpretation or GIS where the area is small, subwatershed and stormwater /master plan estimates where they have been done, municipal zoning requirements and golf course irrigation Permits to Take Water (PTTW). Municipal Property Assessment Corporation (MPAC) property layer often categorizes information on golf courses using code 490. As with agricultural managed lands, in cases where there are both the time and resources available, or where uncertainty is high as a result of discrepancies of direct measurement, a roadside survey/field checking is recommended as confirmation/support of the air photo interpretation or GIS to reduce the uncertainty and make adjustments on the identification of golf courses.

Alternatively, the National Golf Course Owners Association of Canada has a list of its members on their website (see www.ngcoa.ca) which can help locate golf courses that are in the region. The Municipal Property Assessment Corporation (MPAC) property layer often categorizes information on golf courses using code 490. Using the MPAC layer would give the location and area of golf courses that may be in the vulnerable areas. Aerial photos help to identify the actual golf course areas that would be considered managed lands, omitting the forested areas, wetlands and large rivers and lakes.

For example, within the Grand River Watershed of the Lake Erie Source Protection Region, GRCA staff examined aerial photos overlaid with UTM coordinates of golf course irrigation PTTWs. Local knowledge helped fill in the gaps to include the rest of the courses that may be on municipal supply and not need a PTTW. Figure 1 shows the golf course locations in the Lake Erie Source Protection Region watersheds.

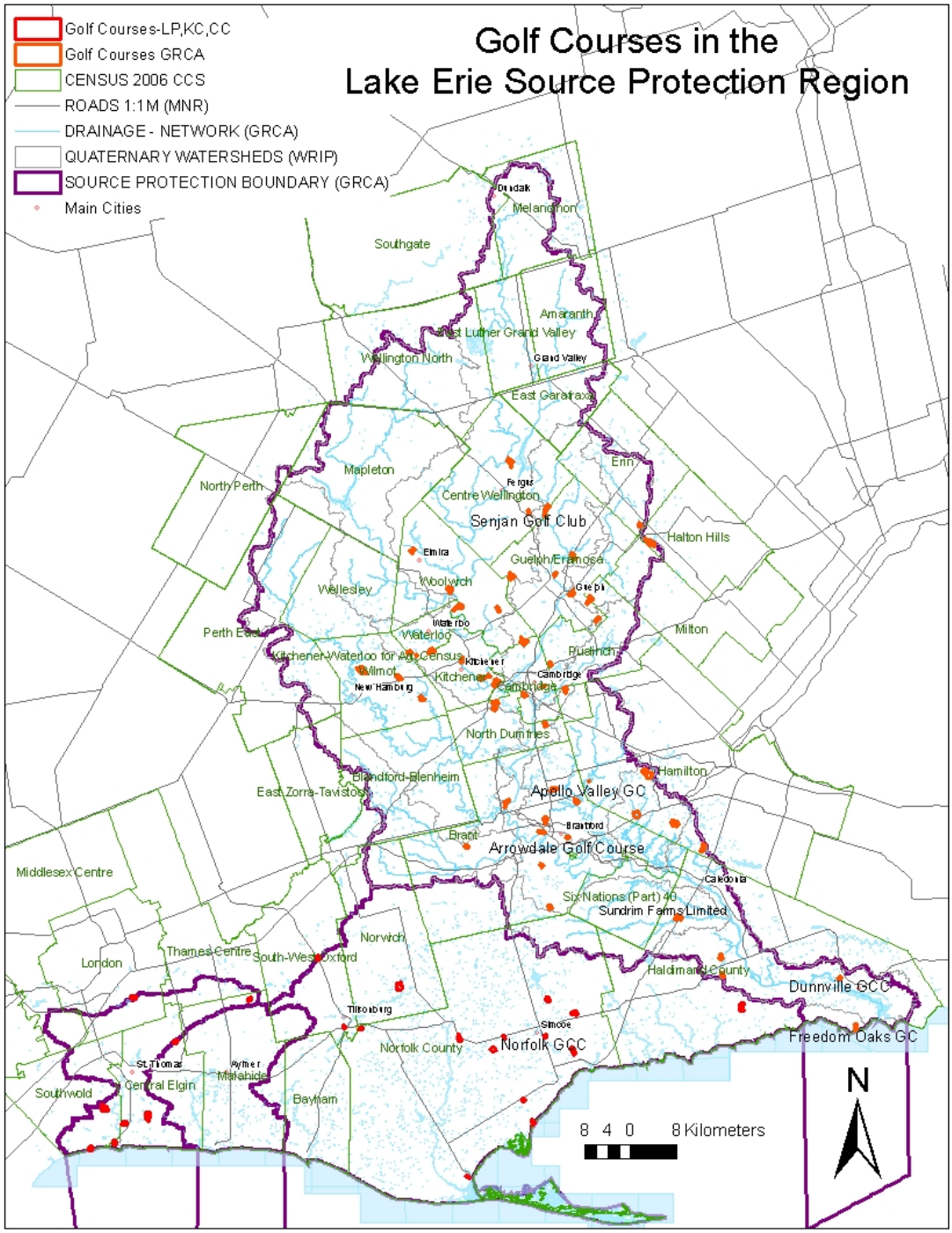

Figure 1: Golf Courses in the LESPR

Residential/Commercial/Institutional Lawn and Sports Fields

Determination of total managed land includes an estimate of residential, commercial and institutional land area that could receive application of fertilizer (i.e. the lawn/turf area). Recognizing that property size varies across the province, the appropriate method to estimate lawn area will vary by SPA depending on local knowledge and availability of information. Direct measurement and photo interpretation can be used where the area is small. In cases where there are both the time and resources available, or where uncertainty is high as a result of discrepancies in the data collected, a roadside survey/field checking is recommended as confirmation/support of the air photo interpretation to reduce the uncertainty and make adjustments on the identification of pervious urban areas.

Subwatershed plans, storm water management plans/master plans, and other hydrologic studies frequently include estimates of percent impervious surface, which can be used indirectly to estimate the percent grassed area (assuming that pervious surfaces are grassed). Some municipalities will record this information in their official plans (OP's).

Some municipal zoning by-laws specify lot coverage maximums from which grassed areas can be indirectly derived. Some examples:

- In Toronto, for example, the maximum structure size is 35% (municipal zoning lot coverage max) + 10% driveway leaving a grass area of 55%. Similarly in Mississauga, the maximum structure size is 25% + 10% driveway leaving a grass area of 65%.

- In Kitchener, the impervious cover analysis was done for a subwatershed study showing a range between 45% to 65% imperviousness in residential areas, including roads. This would leave between 35% to 55% grassed areas, depending on the age of the subdivision and type of housing (low density or multi-residential).

These estimates try to integrate areas where lot coverage is higher (i.e. townhouses and office complexes with parking lots) with areas where lot coverage is lower (i.e. neighbourhoods containing parks and larger parcels).

(c) Table of Drinking Water Threats: Thresholds for Percentage of Managed Lands

As a conservative estimate of risk, it is assumed that all managed lands receive some type of nutrient application. The thresholds defined in order to evaluate the risk of over-application of nutrients in a vulnerable area or subsets of this area are:

- If managed lands in total account for less than 40% of the vulnerable area or subsets of this area, the area is considered to have a low potential for nutrient application to be causing contamination of drinking water sources,
- If managed lands in total account from 40% to 80% of the vulnerable area or subsets of this area, the area is considered to have a moderate potential for nutrient application to be causing contamination of drinking water sources, and

- If managed lands in total account for over 80% of the vulnerable area or subsets of this area, the area is considered to have a high potential for nutrient application to be causing contamination of drinking water sources.

2. LIVESTOCK DENSITY (NU/Acre)

2.1 Calculation of Livestock Density

Livestock density is used as a surrogate measure of the potential for generating, storing, and land applying ASM as a source of nutrients within a defined area. The livestock density is expressed in NU/Acre.

The NUs (NUs) is expressed as:

- The number of animals housed, or pastured, at one time on a Farm Unit, that generate enough manure to fertilize the same area of crop landbase under the most limiting of either nitrogen or phosphorus as determined by OMAFRA's Nutrient Management (NMAN) software

  Or, in the case where no animals are housed:

- The weight or volume of manure or other biosolids used annually on a Farm Unit, that fertilizes the same area of crop landbase under the most limiting of either nitrogen or phosphorus as determined by OMAFRA's Nutrient Management (NMAN) software

The Nutrient Management Protocol defines the Farm Unit as:

1. For agricultural operations that generate a prescribed nutrient:

   - Can be no smaller than a single deed, or
   - Can be no smaller than the landbase of a generating facility under a single continuous roof, or
   - Must include all land receiving nutrients generated on the deeded property, as required by the Nutrient Management Strategy and/or Plan; whether or not the land itself is on the same deed; and
   - Must include nutrient generating facilities on other deeds owned by the same person/corporation if the nutrients generated on these other deeds are utilized on the landbase of the first deed; and
   - If nutrients are generated in different locations on your overall operation and those nutrients are not spread on the same landbase, then these different locations can be two or more separate farm units.

2. For agricultural operations that do not generate, but use nutrients

   - The farm unit can be no smaller than a single field

The calculation of livestock density in a specified area requires the following three steps:

1) Estimate the number of each category of animals present within the specified area,

2) Convert the number of each category of poultry and livestock present into NUs, which are suggested in Section 2.1 of this Technical Bulletin, to enable all livestock to be compared on an equivalent unit of measure in terms of the nutrients produced by each type.

3) Sum the total NU of all categories of poultry and livestock within the specified area and then divide this NU value by the area of agricultural managed land within the same specified area. The applicable area used for the calculation of livestock density (NU/acre) is different for each of the following activities. Rule 1 of the technical rules includes a definition of livestock density, which is calculated over one of two areas described in (a) and (b):

a) In respect of land used for the application of nutrients, the number of NU per acre of agricultural managed land in the vulnerable area or subset of the vulnerable area, and detailed in Section 2.1 of this Technical Bulletin;

For the purposes of estimating the NUs required for the estimation of livestock density in a farm unit, where a portion of a farm unit falls within a vulnerable area, the NUs generated on the entire parcel of land should be factored into the calculations rather than the NUs generated within the portion of land that falls within a vulnerable area.

The rate for livestock density (NU/Acre) shall be calculated by dividing the total NUs generated on the farm unit by the total agricultural managed land within this farm unit. By calculating the rate for livestock density for the entire farm unit, this rate is already prorated to the portion of the farm that is in the vulnerable area.

For example, a farm unit has 200 acres of crop area, and ½ of the crop area is located within the vulnerable area. The barn can be located either inside or outside the vulnerable area, and the farm unit has 100 cows, generating about 100 NU. The NU generated on this farm unit very likely will be used on its own crops. Therefore, the NU/acre is 100NU/200 acres = 0.5 NU/acre. Then, for this example, the area of “agricultural managed land” to be accounted within the vulnerable area is 100 acres, and the livestock density is 0.5 NU/acre.

b) In respect of land that is part of a farm unit and that is used for livestock grazing or pasturing, the number of NUs per acre that is used for those purposes, and detailed in Section 2.4 of this Technical Bulletin.

The land use data required for estimation of the above NU/Acre can be obtained from the same sources as the data required for the identification of managed land. The areas considered to calculate the NUs for each of the agricultural activities are described in Sections 2.2 to 2.4 below.

2.2 Estimating the Number of Animals and Nutrient Units for Use in Livestock Density Calculations

The *Nutrient Management Act* developed a method of comparing livestock nutrient generation by converting the number of individual livestock into NU. This technical bulletin provides two methods to obtain the number of NU in a vulnerable area or subset of the vulnerable area. The first method is using a barn size calculation to estimate NU. The second method is converting actual animal numbers using the NU conversion table in the *Nutrient Management Protocol* of the *Nutrient Management Act*.

(a) *Estimating Nutrient Units based on the Square Footage of the Barn*

To estimate NUs based on square footage requires a three step approach. The first step is identifying the type of livestock operation on a farm unit. This may be accomplished two ways. Firstly, the Municipal Property Assessment Corporation (MPAC) farm classification system can be used to identify the farm use on a property (i.e. Dairy, Swine, Beef, etc.). The air photography and/or road side surveys, as described in Appendix A, can be used to address inconsistencies between MPAC data and local knowledge.

The MPAC data identifying the land use may in some cases be missing, an air photo interpretation helps to confirm the identification of barns and therefore to refine the estimates of the number of animals. For small areas a roadside survey as confirmation/support of the air photo interpretation is recommended to confirm the location of the barns and number of barns, as well to reduce the uncertainty on the identification of the number and type of animals that a farm unit may hold.

Once the type of livestock operation is known, the second step is to estimate the area of the livestock building. The square footage of each identified livestock building can be estimated using air photography and a GIS area measurement tool.

Once the livestock type and the barn dimensions are known, Table 1 below, or Tables 4 through 6, which can be found in Appendix B, may be used to estimate the number of NU on the farm unit. If there is no available detailed data about the property then Table 1 should be used. If more detail about the operation is known then Tables 4 through 6 in Appendix B should be used.

Table 1 below contains barn area per NU conversions based on the MPAC farm classification system. Tables 4 through 6 also provide barn area per NU conversion, but more detailed and specific to livestock sub-type (i.e. milking age cows, heifers, calf) and livestock sub-sub-type (i.e. freestall, tie stall and bedded pack) if such data is available.

For example, if a road side survey determines that a dairy farm houses Jersey cows, then Table 4 should be used to refine the calculation for that farm.

However, local knowledge or direct contact with property owners will always take precedence over any information gathered through this method.

Table 1: *NU Conversion Factors based on barn size for different MPAC farm classifications.*

MPAC Classification	Sq.ft./NU	Sq.m./NU
Dairy	**120**	**11**
Swine	**70**	**7**
Beef	**100**	**9**
Chickens	**267**	**25**
Turkeys	**260**	**24**
Horse	**275**	**26**
Goat	**200**	**19**
Sheep	**150**	**14**
Fur	**2400**	**223**
Mixed	**140**	**13**

(b) ***Estimating Nutrient Units based on documented animal numbers***

The number of animals can be obtained by using the MPAC data and contacting the landowners within the vulnerable areas directly. The MPAC farm classification system can be used to identify the farm use on a property (i.e. Dairy, Swine, Beef, etc.). Information of number of livestock per farm units may also be available for some areas by contacting the Ontario Cattlemen's Association.

For conversion of the number of individual livestock into NUs, see http://www.omafra.gov.on.ca/english/livestock/index.html for each livestock type under Manure and Nutrient Management by commodity. The values that can be used to convert estimated poultry and livestock numbers into NUs are also provided in Table 2 below.

Table 2: ***Nutrient Unit Conversion Factors for Poultry, Cattle and Swine and Other Types of Livestock***

Livestock Category	Agricultural Census Category(s)	Description of Operation from OMAFRA (or surrogate for AgCensus Category)	Nutrient Unit Conversion Factor	**Divide # of Animals by NU Conversion Factor**
Poultry	layhen	Laying Hens (number of layer spaces in barn - after pullet stage, until end of laying period)	150 birds/NU	150
	pulets	Layer Pullets (number of pullet spaces in barn - day old to laying)	500 pullets/NU	500
	broiler	Chicken Broilers (8-week cycle)	351 birds/NU	250
		Chicken Broilers (9-week cycle)	300 birds/NU	
		Chicken Broilers (10-week cycle)	250 birds/NU	
		Chicken Broilers (12-week cycle)	199 birds/NU	
		Chicken Broiler Breeders (layers and roosters transferred in from growing barn)	100 birds/NU	
		Broiler Breeders (growing - pullets and cockerels transferred out to layer barn)	300 pullets/NU	
	turkey	Turkeys - Broilers/Hens/Toms/Pullets (total square feet of floor growing area)	58 birds/NU	58
	chick	Average of all chickens	300 chickens/NU	300
	tothplt	Average of all Other Poultry	245 birds/NU	245.33
Cattle	tbfcows	Beef Cows Includes calves to weaning	1 animal/NU	1
	tsteers	Beef Backgrounders 261-408 kilograms (575-900 pounds)	3 animals/NU	3
	bfheif	Beef Feeders 261-567 kilograms (575-1,250 pounds)	3 animals/NU	3
	fdheif	Beef Feeders 261-567 kilograms (575-1,250 pounds)	3 animals/NU	3
	mlkcow bulls	Dairy Cows (Large Frame, i.e. Holstein) 545-636 kilograms (1,200-1,400 pounds)	0.7 animals/NU	0.7
	mlkheif	Dairy Heifers (Large Frame, i.e. Holstein) 182-545 kilograms (400-1,200 pounds)	2 animals/NU	2
	calfu1	Dairy Calves (Large Frame, i.e. Holstein) 45-182 kilograms (100-400 pounds)	6 animals/NU	6
	cow	Average all Cows	0.85 animals/NU	0.85
Swine	tsows	Lactating-Age Sows - includes weaners to 6.8 kilograms (15 pounds)	3.33 animals/NU	3.33
	grwpig	Finishing Pigs Number of spaces in barn for animals between 27.3-104.5 kilograms (60-230 pounds)	6 animals/NU	6
	boars	SEW Sows Lactating-Age Sows - includes weaners to 6.8 kilograms (15 pounds)	3.33 animals/NU	3.33
	nurpig	SEW Weaners 6.8-27.3 kilogram (15-60 pounds)	20 animals/NU	20
		Average of All Swine	0.858 animals/NU	8.165

Livestock Category	Agricultural Census Category(s)	Description of Operation from OMAFRA (or surrogate for AgCensus Category)	Nutrient Unit Conversion Factor	**Divide # of Animals by NU Conversion Factor**
Sheep	ewes rams	Sheep - Meat Breeding Ewes - includes lambs to 32 kilograms (70 pounds) (most sheep in GRCA are for meat)	8 animals/NU	8
	lambs	Feeder Lambs 32-57 kilograms (70-125 pounds)	20 animals/NU	20
Other Livestock	horses	Horses Medium Frame Includes foals to weaning from 227-680 kilograms (500-1,500 pounds)	1 animal/NU	1
	goats	Goats – Dairy milking-age does (includes kids, replacements and bucks)	8 animals/NU	8
	wldboar	Wild Boar - Breeding Age Sows Includes boars, replacements, and weaned piglets to 27 kilograms (60 pounds)	5 animals/NU	5
	fox	Fox Breeding Females Includes replacements, market animals and males	25 animals/NU	25
	mink	Mink Breeding Females Includes replacements, market animals and males	90 animals/NU	90
	bison	Bison Adults Includes unweaned calves and replacements	1.3 animals/NU	1.3
	lamas	Llama Adults or Alpaca Adults Includes unweaned young and replacements	5 animals/NU 8 animals/NU	6.5
	elk	Elk Adults** (24 months and older)	2 animals/NU	2
	deer	Deer (average of red, white tail and fallow) (24 months and older)	10.33 animals/NU	10.33
	rabbits	Breeding Does (includes replacements, market animals and males)	40 animals/NU	40

2.3 Livestock Density for Land Application of Nutrients (NU/Acre)

(a) Area Used to Calculate Livestock Density for Land Application of Nutrients

For the purposes of determining the circumstances related to the application of nutrients, the livestock density (NU/acre) is calculated using the areas of '*managed agricultural land'* within each of the vulnerable areas or subset of the vulnerable areas as the denominator, as described in Section 1.1(a) of this bulletin. In other words, the total NUs of all livestock generated in the vulnerable area or subset of the vulnerable area divided by the acreage of *Agricultural Managed Lands within this area equals the livestock density in NU/acre*.

As detailed in Section 2.1, for the purposes of estimating the NUs and therefore the rate of livestock Density (NU/) within the vulnerable area or subset of the area, where a portion of a farm unit falls within a vulnerable area, the NUs generated on the entire parcel of land should be factored into the calculations rather than the NUs generated within the portion of land that falls

within a vulnerable area, as this is then prorated by making it a NU/acre rate of application, which will apply to the portion of land in the vulnerable area.

(b) Table of Drinking Water Threats: Livestock Density Thresholds for Land Application of Nutrients

The conservative assumption used as the basis for this calculation is that a higher NU density results in a greater concentration of nutrients (the chemical threat) present in an area for storage, and land application and therefore an increased potential for nutrient contamination of source waters within the vulnerable area. For land application of ASM, a high livestock density in an area suggests an increased potential that over-application of ASM may occur as adequate land-base to properly dispose of all the ASM may not exist. In areas with low livestock density adequate land-base is more likely to exist to properly dispose of the ASM. Commercial fertilizers will likely be used to compensate for any under supply of ASM-based nutrients. The amounts applied, however, are regulated by the fact that this is a purchased crop input. The rational is that growers will want to closely match commercial fertilizer applications to crop requirements to minimize their cost of crop production.

The thresholds defined in order to evaluate the risk of over-application of ASM are:

- If livestock density in the vulnerable area is less than 0.5 NU/acre, the area is considered to have a low potential for nutrient application exceeding crop requirements,
- If livestock density in the vulnerable areas is over 0.5 and less than 1.0 NU/acre, the area is considered to have a moderate potential for nutrient application exceeding crop requirements, and
- If livestock density in the vulnerable areas is over 1.0 NU/acre, the area is considered to have a high potential for nutrient application exceeding crop requirements.

2.4 Livestock Density for Use of Land as Livestock Grazing or Pasturing Land, an Outdoor Confinement Area or a Farm-Animal Yard (NU/Acre)

(a) The Use of Land as Livestock Grazing or Pasturing Land

For the use of land as livestock grazing or pasturing land within the vulnerable areas, the NUs shall be calculated only for animal species that have the potential to be pastured in the same manner as above, but the area used for the calculation of livestock density shall be considered at the farm level. The nutrients generated at an annual rate for the circumstances under Table 1 of the technical rules shall be determined by the number of NU for the farm divided by the size of the livestock grazing land or pasturing land.

As detailed in Section 2.1, for the purposes of estimating the NUs and then the NU/Acre within the vulnerable area or subset of the area, where a portion of a farm unit falls within a vulnerable area, then the entire livestock grazing land or pasturing land should be factored into the calculations over the full area, to create a NU/acre that applies to the portion of land within the vulnerable area.

(b) The Use of Land as Livestock Outdoor Confinement Area or a Farm-Animal Yard

For the use of land as livestock outdoor confinement area (OCA) or a farm-animal yard within the vulnerable areas, the NUs shall also be calculated only for animal species that have the potential to dwell in an outdoor confinement area at the farm level. The nutrients generated at an annual rate for the circumstances under Table 1 of the Technical Rules shall be determined by the number of NU for the farm divided by the size of the livestock OCA or a farm-animal yard in hectares.

Furthermore, where a portion of the grazing and pasture, OCAs and farm-yards of a farm unit falls within a vulnerable area, then the entire parcel of land for these purposes should be factored into the calculations over the full area, to create a NU/acre that applies to the portion of land within the vulnerable area.

3. CLARIFICATIONS OF THREATS RELATED TO APPLICATION OF NUTRIENTS

Table 1 of the Tables of Drinking Water Threats requires that you consider the maps for both percentage of managed lands and livestock density when evaluating the circumstances with regard to each of the thresholds for land application of nutrients. Table 3 illustrates the chemical hazard scorings for various combinations of percentage of managed lands and livestock densities. These are the consolidated hazard scores, incorporating the quantity, toxicity and fate scores. The highlighted combinations of percentage of managed land and NU/Acre give a hazard rating for land application of nutrients that, when combined with the area vulnerability scores of 9 or 10, would result in significant risk to source waters.

Table 3: ***Chemical Hazard Scorings for Various Combinations of Percentage of Managed Lands and Livestock Densities***

Groundwater Chemical Hazard Scores

Percentage Managed Land to Total Land	**Nutrient Units per Acre of Cropland**		
	< 0.5 NU/acre	0.5 to 1.0 NU/acre	> 1.0 NU/acre
> 80%	**8 Significant in areas of Vuln=10**	**8.4 Significant in areas of Vuln=10**	**8.4 Significant in areas of Vuln=10**
40 to 80%	6.8	7.6	**8.4 Significant in areas of Vuln=10**
< 40%	6	6.8	**8 Significant in areas of Vuln=10**

Surface water Chemical Hazard Scores

Percentage Managed Land of Total Area	Nutrient Units per Acre of Cropland		
	< 0.5 NU/acre	0.5 to 1.0 NU/acre	> 1.0 NU/acre
> 80%	**8.8 Significant in areas of Vuln=10**	**9.2 Significant in areas of Vuln=10 or 9**	**9.2 Significant in areas of Vuln=10 or 9**
40 to 80%	7.6	**8.4 Significant in areas of Vuln=10**	**9.2 Significant in areas of Vuln=10 or 9**
< 40%	6.8	7.6	**8.8 Significant in areas of Vuln=10**

4. CLASSIFICATION OF THREATS RELATED TO THE USE OF LAND FOR LIVESTOCK GRAZING OR PASTURING OR OUTDOOR CONFINEMENT AREA OR A FARM-ANIMAL YARD

In general, the use of land as livestock grazing or pasturing land will be a **significant chemical threat in Vulnerable Areas scoring 9 or 10** if:

- **Vulnerable Areas scoring 9** if the livestock density is sufficient to generate nutrients at an annual rate that is more than 1.0 NU/Acre; or
- **Vulnerable Areas scoring 10** if the livestock density is sufficient to generate nutrients at an annual rate that is at least 0.5 NU/Acre for surface water or more than 1.0 NU/Acre for groundwater**;** and
- the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater.

Note: the tables include Phosphorus in groundwater, but do not identify any threats associated with it.

The use of land as livestock outdoor confinement area or a farm-animal yard will be a **significant chemical threat in**:

- **Vulnerable Areas scoring 10** if the number of animals confined in the area at any time is sufficient to generate nutrients at a rate of more than 300 NUs per hectares of the area annually for groundwater and at a rate of more than 120 NUs per hectares of the area annually for surface water; or
- **Vulnerable Areas scoring 9** if the number of animals confined in the area at any time is sufficient to generate nutrients at a rate of more than 120 NUs per hectares of the area annually for surface water; and
- the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater.

5. CLASSIFICATION OF THREATS RELATED TO ASM STORAGE

ASM storage includes: 1) storage at or above grade in or on a permanent nutrient storage facility, 2) storage at or above grade on a temporary field nutrient storage site, 3) storage below grade in or on a permanent nutrient storage facility, and 4) storage where a portion, but not all, of the ASM is stored above grade in or on a permanent nutrient storage facility. A barn is considered a threat when it is used to store ASM.

It is assumed that a high amount of NUs on a farm unit suggests the possibility of point source release of a large quantity of ASM. It is also assumed that if the farm unit has a high value of NUs, the livestock density (NU/acre) for land application would be high.

Therefore, the technical rules state that the use of land to store ASM would be a **significant chemical threat in Vulnerable Areas scoring 9 or 10** if the weight or volume of manure stored annually on a Farm Unit is sufficient to annually land apply nutrients at a rate that is more than 1.0 NU/Acre of the farm unit. The nutrients stored and applied at an annual rate for the circumstances under the Table of Drinking Water Threats of the technical rules for ASM storage is determined by the NU stored **on farm** divided by **the size of farm unit**.

Furthermore, circumstance 3 for ASM storage is that **a spill** of the material **or runoff** from the area where the material is stored (i.e. a point source release) may result in the presence of Nitrogen or Phosphorus in groundwater or surface water.

The tables of drinking water threats assume that generation of ASM is linked to the application of ASM in the farm unit and therefore circumstances are linked to application rates. If this is not the case, the SPC's can consider requesting the addition of other circumstances for ASM storage. For example:

- Storage of ASM where the NUs generated on the farm unit are more than 200 NU;
- Storage of ASM where the NUs generated on the farm unit are less than 200 NU but more than 100 NU;
- Storage of ASM where the NUs generated on the farm unit are less than or equal to 100 NU;

APPENDIX A: EXAMPLE OF CALCULATIONS

This working example has been undertaken by GRCA and OMAFRA in order to illustrate the process of calculating the % of managed land and livestock density for land application of nutrients. A WHPA within the Lake Erie Source Protection Region (LESPR) was selected for this exercise. The vulnerable areas have been delineated according to the technical rules. An illustration of the WHPAs A, B and C is presented in Figure 3 in the example below.

(a) Determining amount of "managed land" and "agricultural managed land"

Section 3 of this bulletin states that the *managed land* and *% managed land* areas must be calculated for each of the wellhead protection areas WHPAs A,B and C, and for each of the intake protection zones IPZ1 and IPZ2. The suggested method is to use a GIS/aerial photo-based approach to calculate the amount of agricultural managed land and tillable land within the vulnerable areas.

For this example, a simplified approach was taken for illustrative purposes, and the managed land and % of managed lands were calculated for a combined area of WHPA A, B and C as:

- WHPA A+B = the 2 year TOT boundary
- WHPA A+B+C = the 5 year TOT boundary

For this wellfield example, the percentage of managed land was calculated using ArcGIS as:

Total defined Vulnerable Area = 5865 acres

This total can be broken down as follows:

- WHPA-A = 76 acres
- WHPA-B = 3262 acres
- WHPA-C = 2527 acres
- Total = 5865 acres

For this example, managed lands within the WHPA were calculated using GIS as:

Managed Lands = Vulnerable Area (WHPA A, B and C) – (build up areas) – (areas of pits and quarries) – (areas of Woodlands) – (Large Rivers and Lakes) – (wetlands)

For illustrative purposes, the example considered that large open spaces (such as golf courses in the picture) are considered "pervious" and may or may not receive nutrients. The example in Figure 2 below (north part of the picture) shows impervious in purple and pervious in green. Therefore, the total managed lands for this example were estimated using GIS as:

- WHPA A + B = 3120 acres
- WHPA A + B + C = 5114 acres

Fig 2: Impervious versus Pervious Areas for the WHPAs A, B and C areas

Therefore, the percentage of managed land to total land is calculated as managed land/WHPA:

- WHPA A + B = 93 %
- WHPA A + B + C = 87 %

For this example, the description of managed land included only golf courses and playing fields but not pervious areas within urban areas. The built up area in this case represents about 15% of the area of WHPA A+B and the pervious built up area can be assumed as about 7 to 10 %. However, in some situations the pervious portion of the urban area could represent a significant percentage of the total WHPAs that would affect the scoring for the thresholds for moderate or high risk of contamination. Therefore, for these cases the suggested approach suggested in Section 3.1(b) of this bulletin is recommended for calculation of pervious built up areas of *managed lands*.

Agricultural Managed Land (for livestock density calculation) was calculated using GIS as following:

Agricultural Managed Land = (WHPA) – (Built up areas) – (areas of pits and quarries) – (large rivers and lakes) – (wetlands) – (areas of Woodlands)

Resulting in:

- WHPA A + B = 2616 acres
- WHPA B + C = 4534 acres

(b) Determining Nutrient Units (for use in livestock density calculations)

For this example, the NUs within WHPAs A, B and C (i.e. to the 5 year TOT boundary) were calculated using photo interpretation work and MPAC data to identify all buildings that could potentially house farm animals (barns) and estimating the number of animals per barn based on the air-photo-interpreted square footage of the barn.

For illustration, figure 3 shows the locations of Wellheads (red dots represent the WHPA-A), WHPAs B and C, and possible barns within the WHPAs (small black building outlines) using photo interpretation work. Some buildings in the WHPAs were screened out during the photo interpretation since they were obviously not used for livestock housing. Still, in order to briefly verify which building outlined in the photo interpretation work were barns, a quick roadside survey was undertaken to confirm the location of the barns as well as whether the barns would be eventually used to house livestock, and to adjust the findings on number of barns and the type of animals that they may hold.

The air photo interpretation findings in general will take precedence over the MPAC code. For this example, for this area, one farmstead site was identified by MPAC as being “poultry”. From the air photos, however, a lot of large grain bins and connecting elevators were observed present around the buildings. This is not a typical building for poultry barns. It was estimated from the air photos and further confirmed by the roadside survey that the building was actually a grain handling facility.

The square footage of each identified livestock building was estimated using the GIS area measurement tool and the NU’s within each WHPA were then added up using method described in Section 2.1 (a) and Table 2 of this bulletin. Then, the NUs were divided by the area of agricultural managed farm land.